

BES322945

Revit Best Practices in Cast-in-Place and Precast Structural Engineering

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Learning Objectives

- Discover three ways of designing cast-in-place structures in Revit
- Learn about two ways of designing precast structures in Revit—construction documentation development options
- Learn about cases where we may use 3D rebar more effectively in place of 2D
- Discover four possible ways for developing construction documentation in Revit and choosing better

Description

This session will be a review of the construction design stage of five completed buildings that were fully designed in Revit software without using any 2D software. Topics will include methods of cast-in-place concrete building design in Revit; methods of precast concrete building design in Revit; advantages and disadvantages of using 3D rebar; advantages of using Revit for the construction design stage.

About the Speaker

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Author of the Principle for construction designing of large-panel building in Revit.

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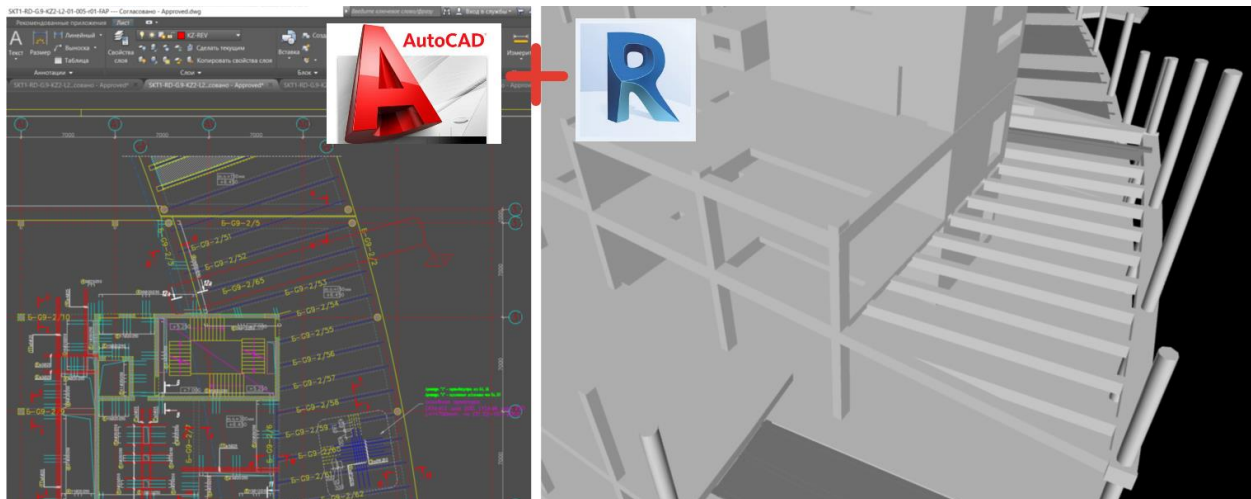
Introduction

Modern architecture necessitates complex shapes and atypical solutions for structures. With the growing pace in construction industry, the time allotted for the building design is decreasing, and designers are also required to make quick and prompt decisions. Traditional 2D design techniques do not meet the needs of customers either in quality or in speed. All of these factors contribute to the transition of design organizations to the full cycle of BIM design. **In this session, we will figure out how to combine a 3D structural model, a drawing set and materials estimation in one platform (Revit) and maintain this relationship throughout the entire project.**

Concrete structure design in Revit

Current situation

Often, the design of reinforced concrete structures requires the presence of a 3D model of a reinforced concrete frame, which is used for spatial calculation and coordination with adjacent departments. Usually all drawings are developed in AutoCAD using traditional technique without direct reference to the elements of a 3D model.



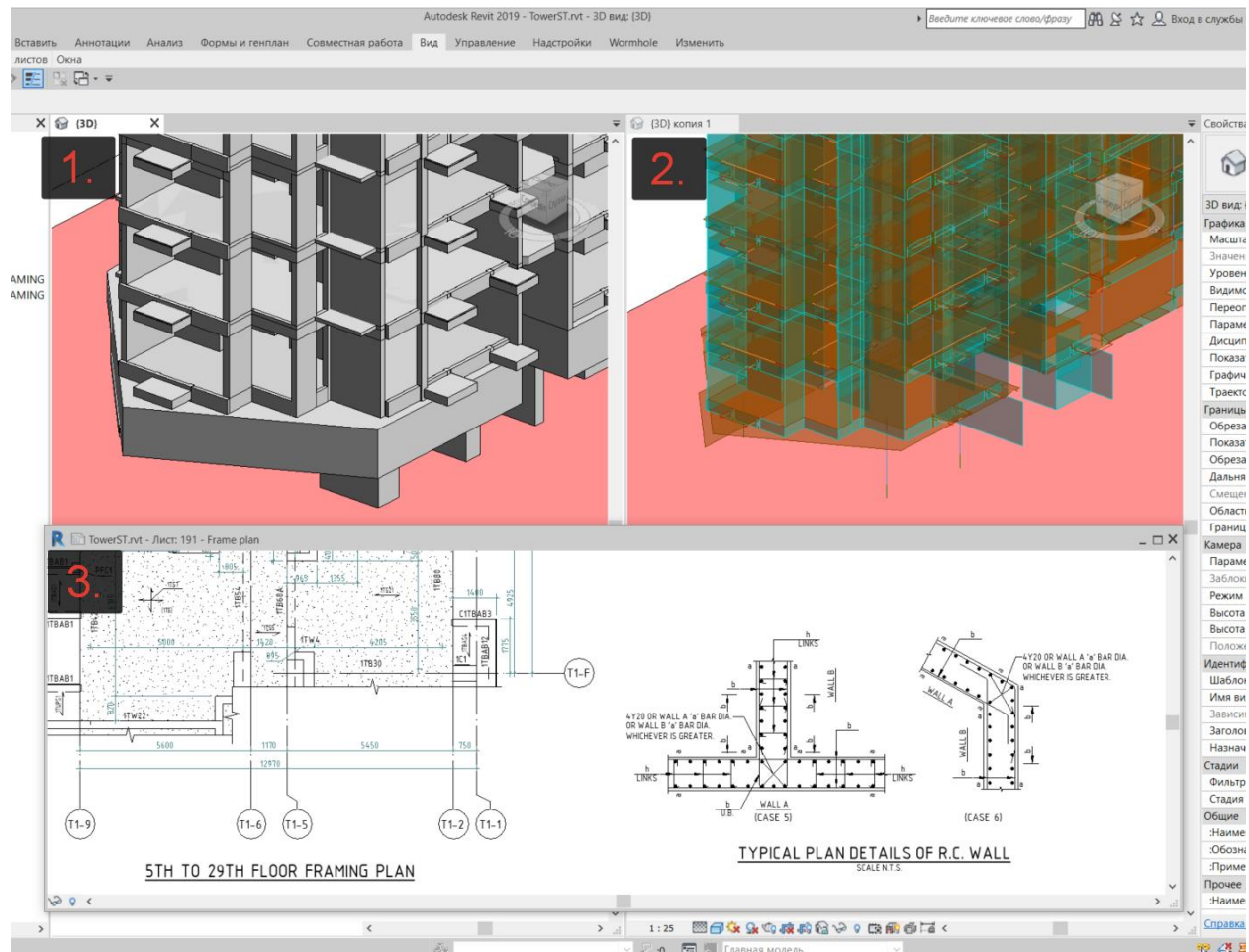
How to organize a complete design cycle in Revit?

Revit was created as a tool for complex BIM design with very flexible interface and tools for modeling and preparation of a drawing set. Moreover, the process of this preparation is more convenient and more logical in many aspects in comparison with AutoCAD.

Design development. (3D_{LOD200} + 2D)

Revit begins to be efficient at the DD stage:

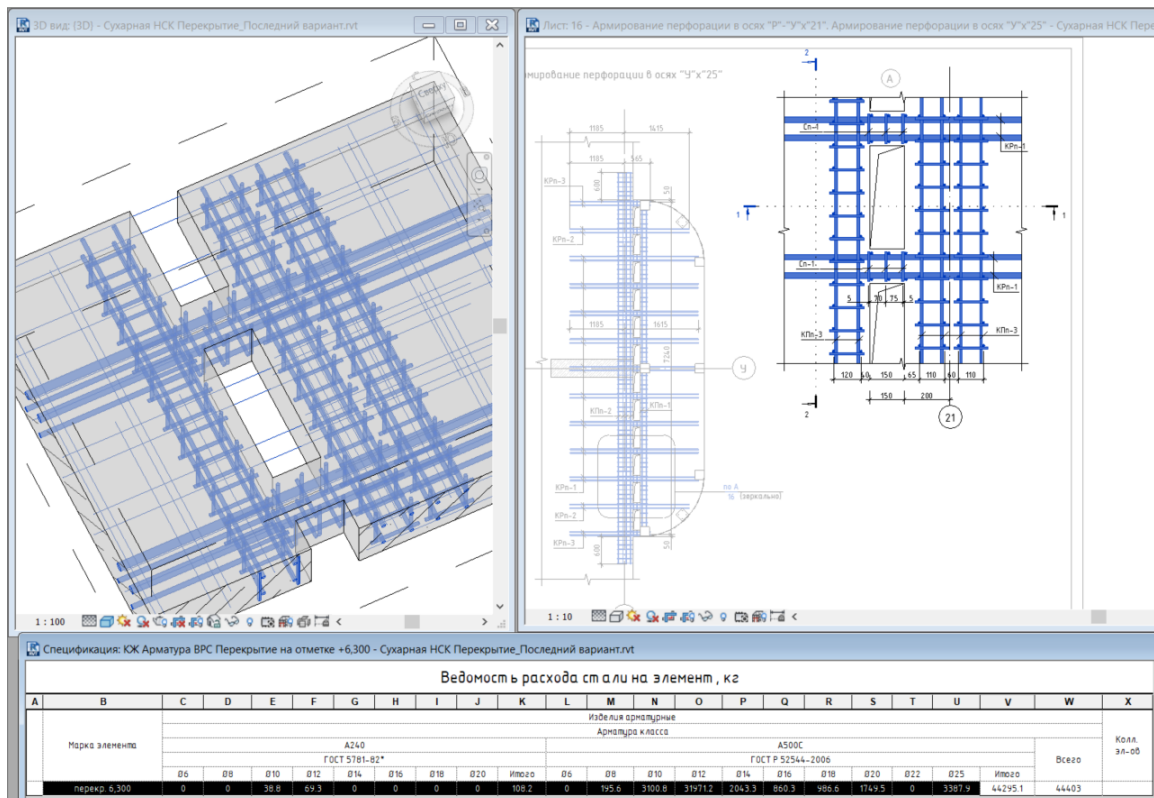
1. The conceptual model is finalized to become the analytical model and is sent to the calculation
2. At the same time, we are starting to design the basic forms of structural elements in Revit
3. At the DD stage, there is no need to model the reinforcement and connections in 3D. But this does not mean that we should return to AutoCAD since Revit has a very convenient annotation functionality



As a result, we get an indivisible BIM model with a drawing set depending on it. We exclude the double work resulting from adjusting the 3D model, the 2D drawings and all the inconsistencies associated with this.

Construction documentation and Shop drawings. (3D – LOD₃₅₀)

At the construction documentation phase we should properly estimate the volume of concrete, the specific amount of metal per structure and elements of other connections. To do this, we are developing a 3D model of reinforced concrete structures in the LOD₃₅₀.



As a result, we get a detailed 3D model of the concrete frame, a set of drawings and properly calculated schedules. As a result when making changes, all the data both in the drawings and in the model and in the specifications remain relevant, which significantly improves the drawing set quality and the entire project.

Construction support (3D – LOD450)

We finalize the model obtained during the design process. After that customers can use it in the construction process:

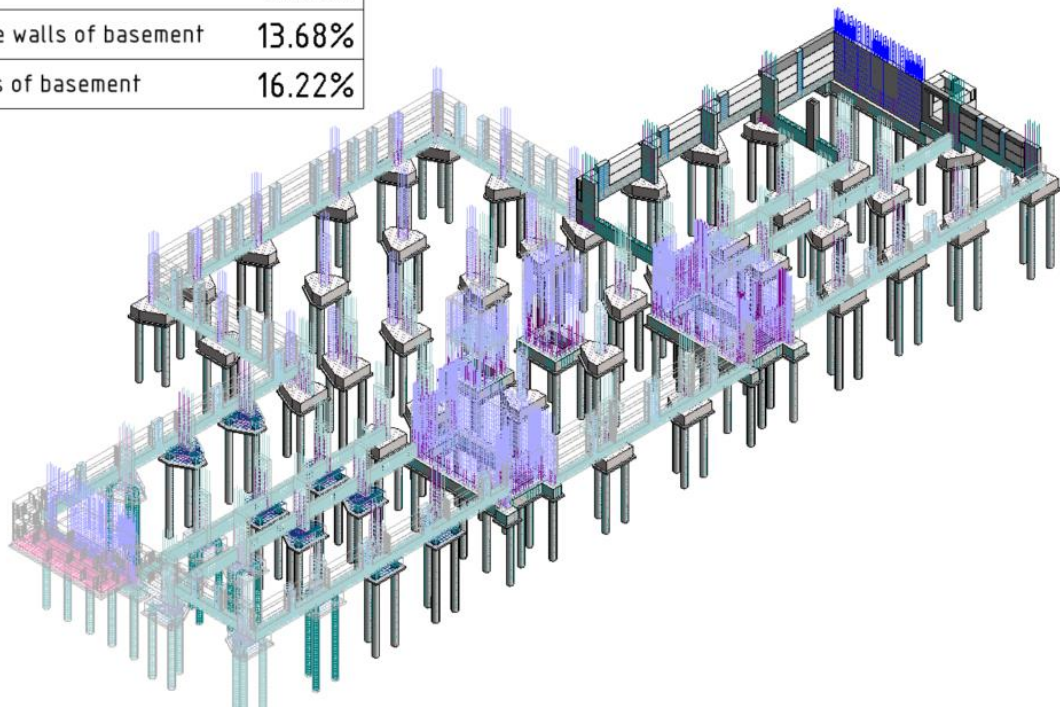
1. Construction site planning
2. Material requirements planning
3. Construction process superintendence

APSG Development

Substructure

Progress at the site:

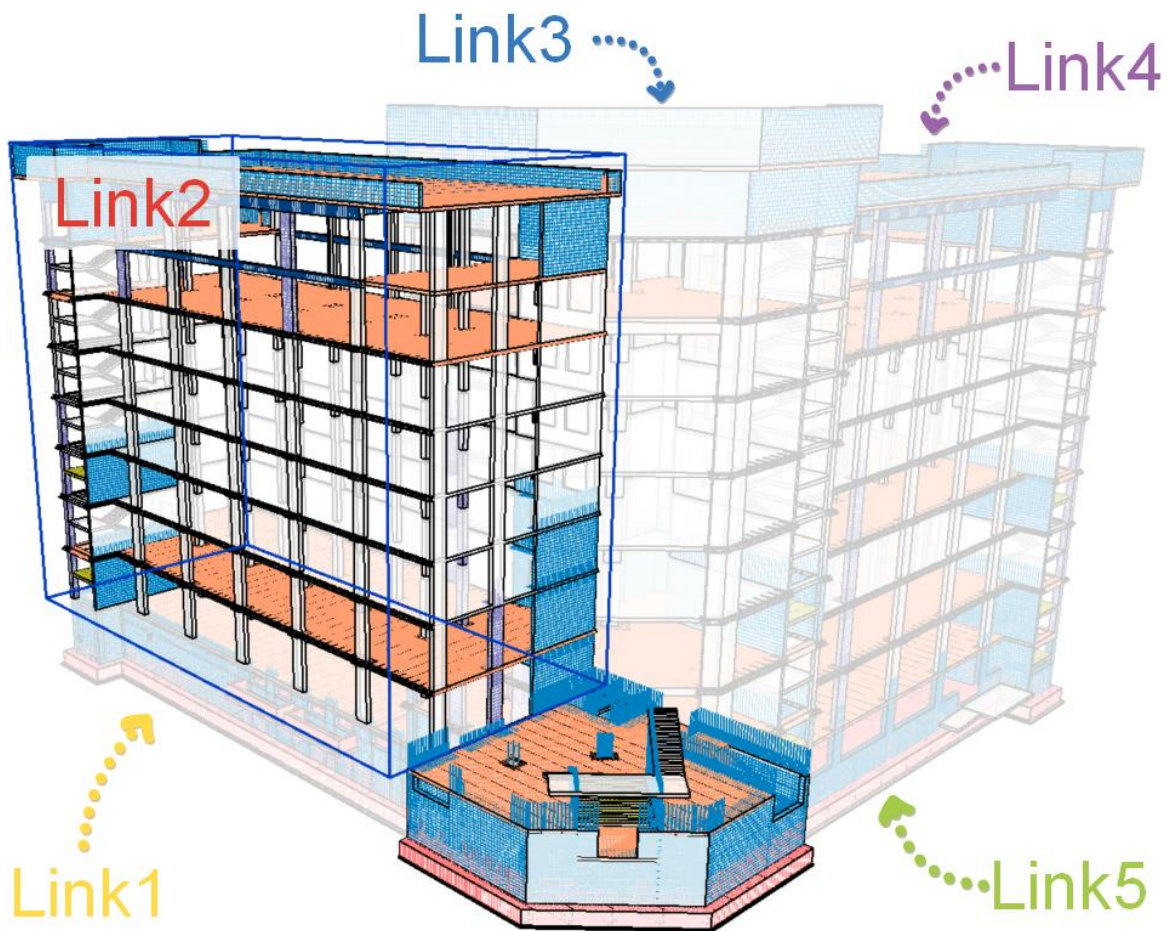
Pile field	87.95%
Foundation	79.12%
Cast-in-place walls of basement	13.68%
Precast walls of basement	16.22%



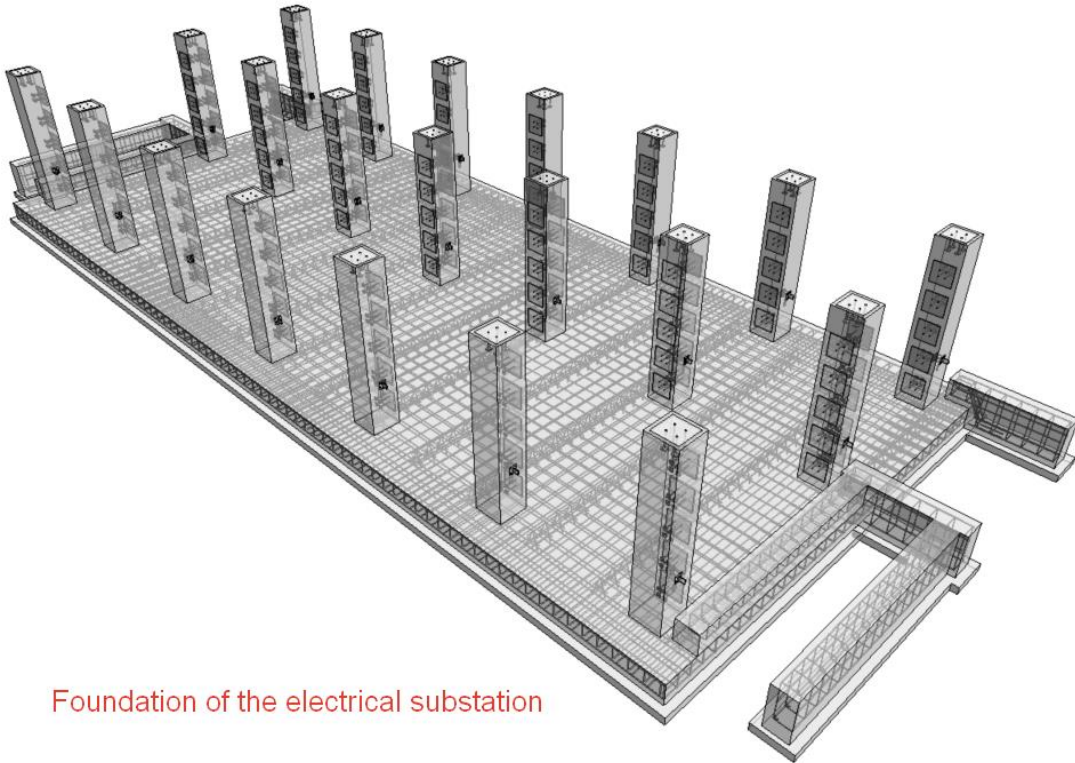
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Possible ways of developing construction documentation in Revit

We have to divide the structural model in Revit into several Links if the building has more than 5000m² (53'000ft²) in total area. Work files typically weigh 200-400Mb and should not be more than 500Mb. Otherwise it will be impossible to work even with a powerful and expensive computer.

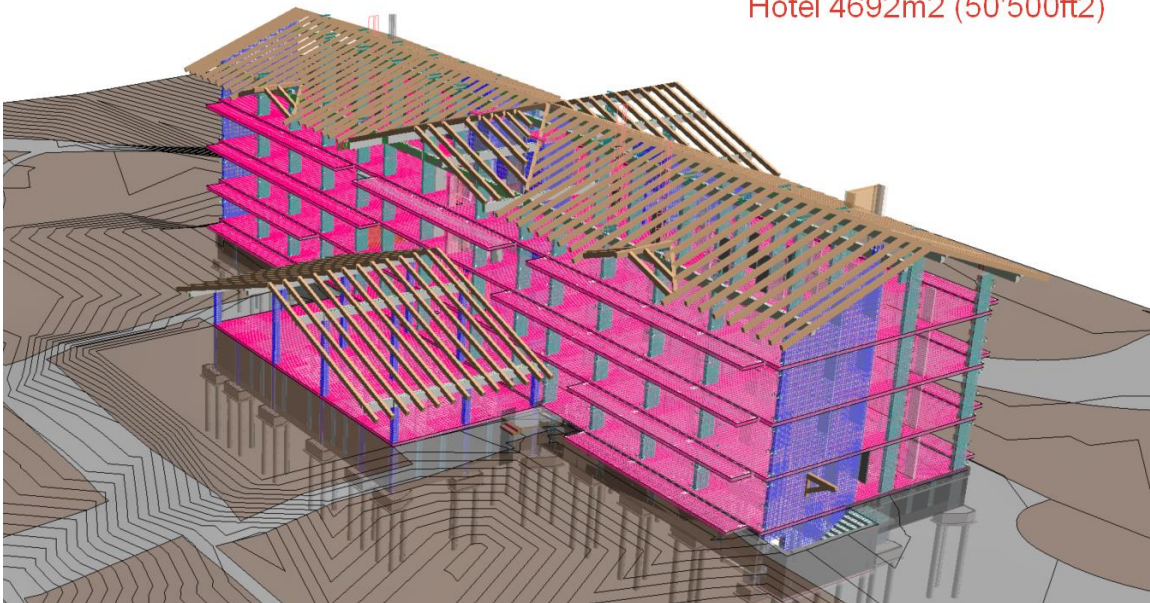


Free-standing buildings and structures less than 53'000 ft² (5000m²) area
As a rule, small buildings and structures in which there are no standard and duplicate elements are developed in a separate file.



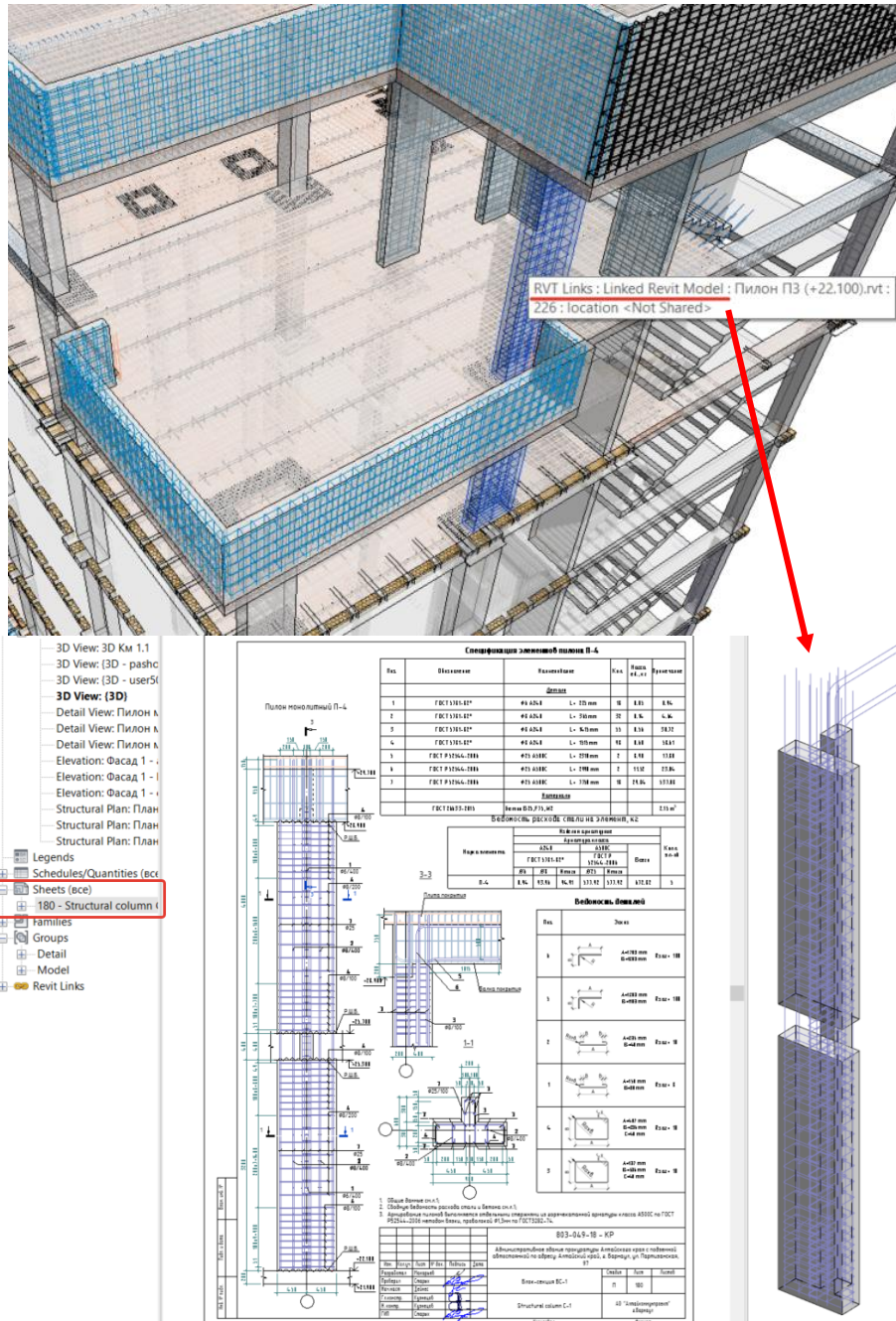
Foundation of the electrical substation

Hotel 4692m² (50'500ft²)



Buildings from 53'000-160'000 ft² (5'000-15'000m²) area

Standard elements usually appear in objects with such area, but the number of design participants does not exceed 1-3 people. To increase the speed of preparation of a set of drawings, we develop and execute drawings for each structural element in a separate file.



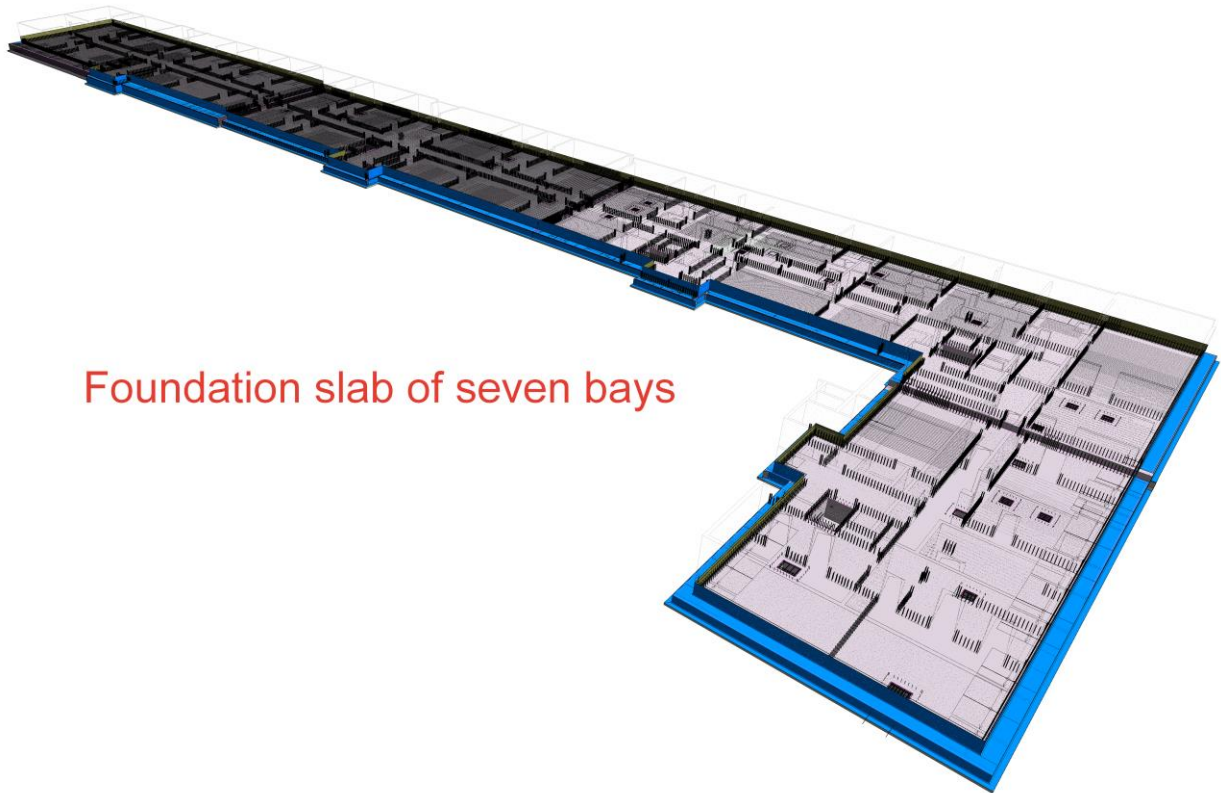
There is no need to create sheets, prepare views, draw up drawings and adjust specifications each time. It is enough to copy an already developed element and make changes.

Buildings larger than 160'000ft² (15'000m²) area

Work with large objects is characterized by:

1. Large volumes and tight deadlines
2. A large number of participants
3. A large number of standard designs and, as a result division of labor

There is a need to create a process of "flow design" in Revit. Thus we divide the building into separate files by type of structure (all vertical structures at the ground floor level, all floor slabs of the first floor), several designers work on each file through Revit Collaboration tools.

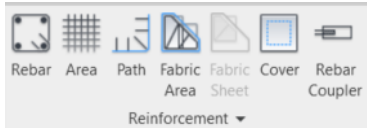


This method is considered the most effective: we significantly accelerate the design process and create a single BIM model for coordination with all participants in the design.

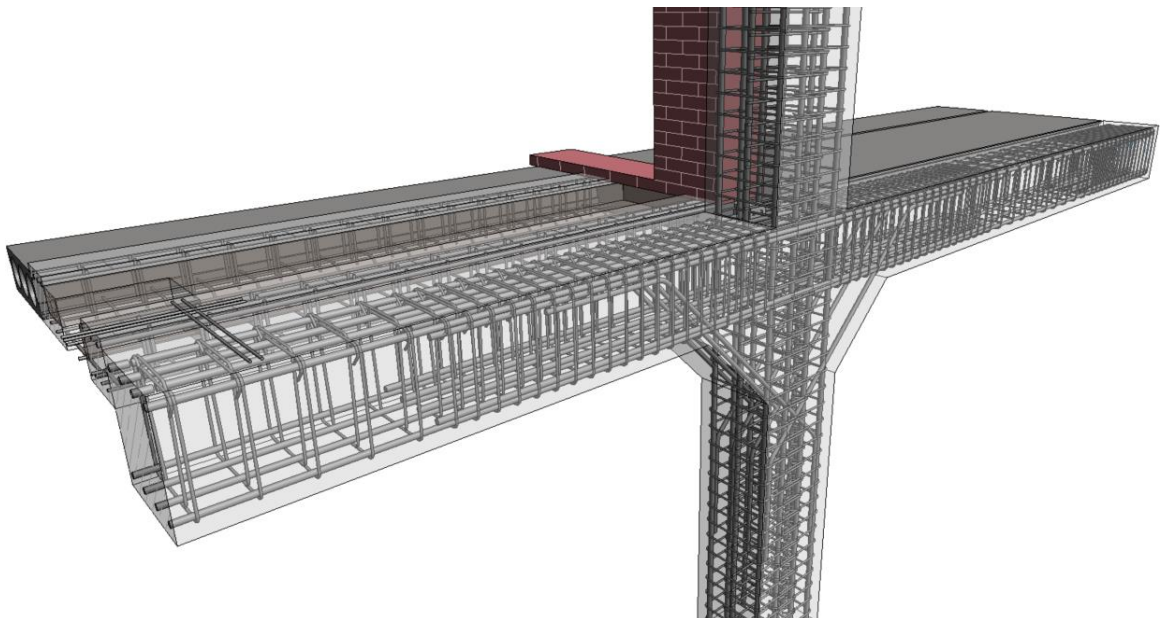
Ways of designing cast-in-place structures in Revit

Going deeper into the topic, we consider 3D practical methods of reinforcing monolithic concrete structures

The common method of reinforcing using standard Revit tools

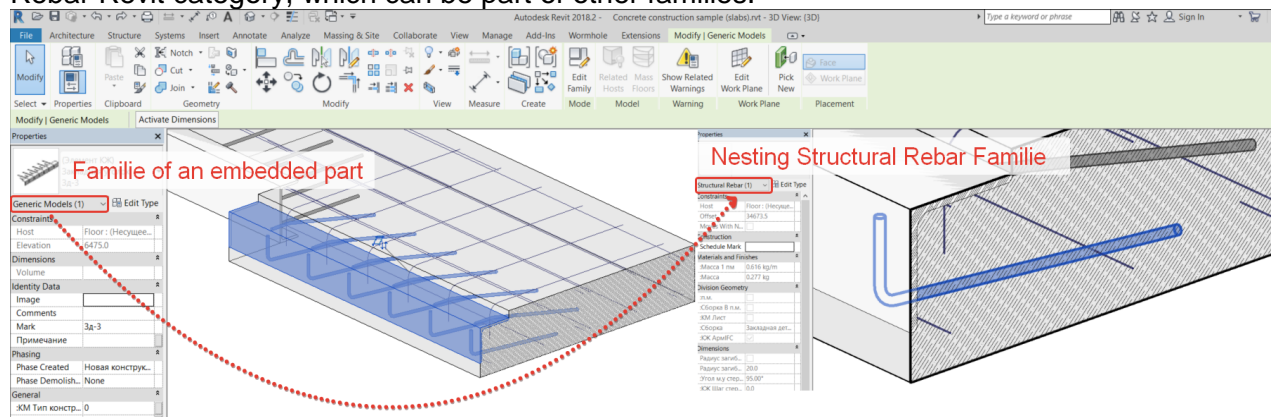


Every year Revit developers add more functionality to Structural Rebar. In turn, we widely use this tool in practice, especially during monolithic structures design.

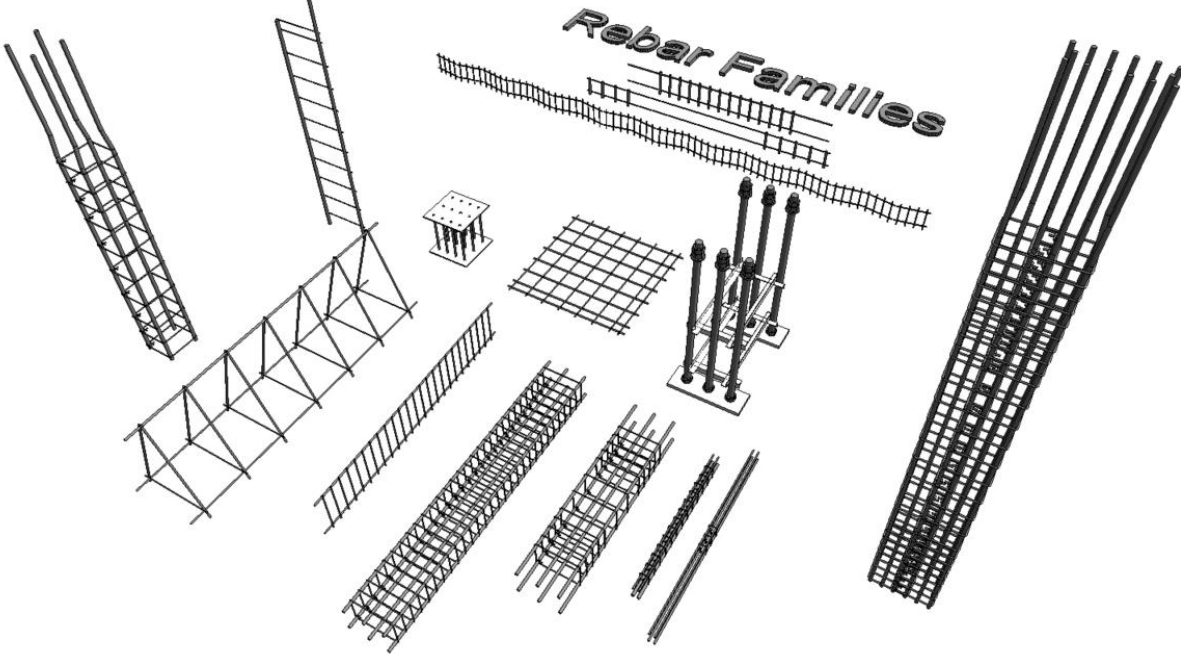


Work with "IFC-rebar" families

By "IFC reinforcement" we mean using parametric families for reinforcement. Due to the fact that there is a large number of prefabricated units (cages, mats, embedded parts) in monolithic structures, designers have found a way to create a family of the Structural Rebar Revit category, which can be part of other families.

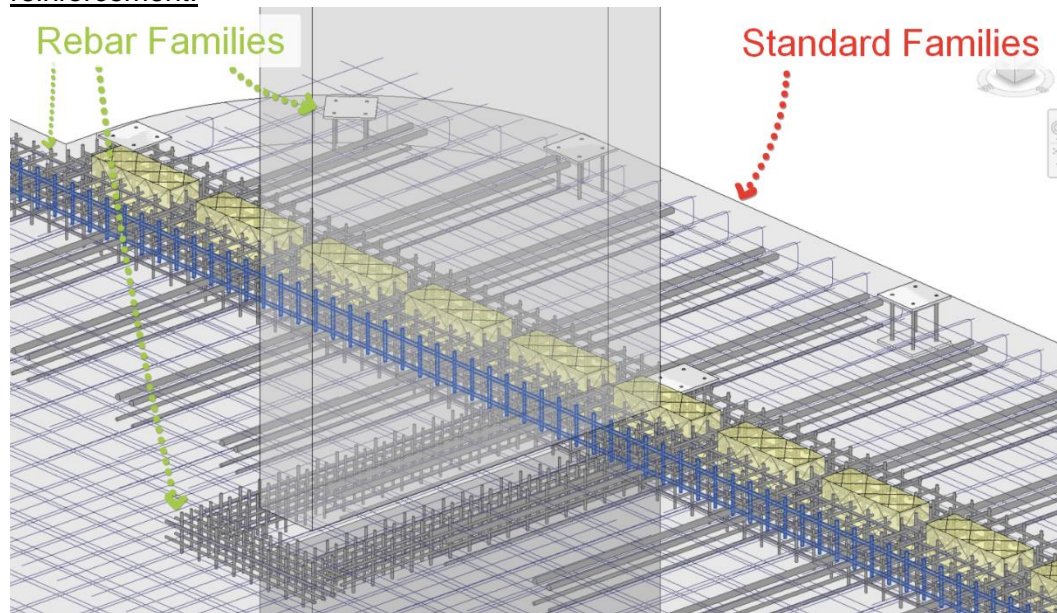


The use of such parametric families significantly accelerates the work in comparison with the use of Groups and Assemblies and allows you to create combined families of embedded parts.



Combined method using both common and IFC methods

Currently, the combined method is widely used. All the reinforcement mounted by individual rods at the site is developed by means of system families, and the prefabricated reinforcement assemblies and embedded parts are made of IFC reinforcement.



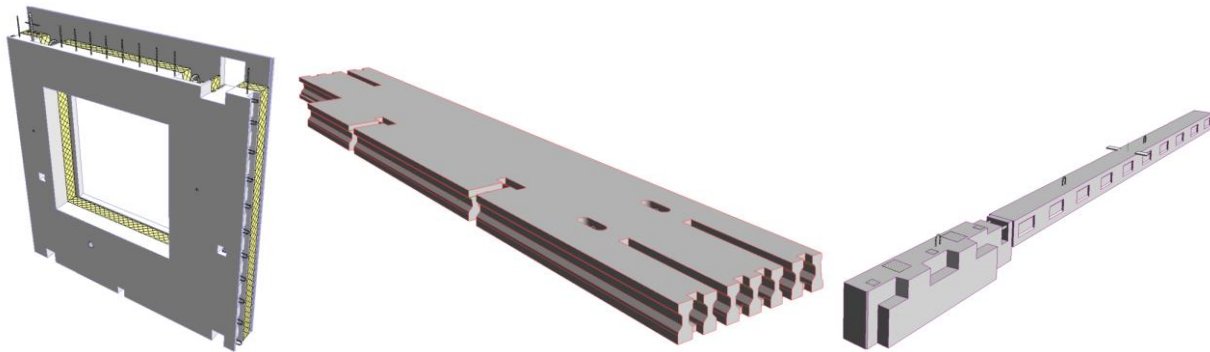
Ways of designing precast structures in Revit

I would like to divide the design of prefabricated concrete structures into the assembly of a 3D model of the building frame and the preparation of a set of unit's shop drawings.

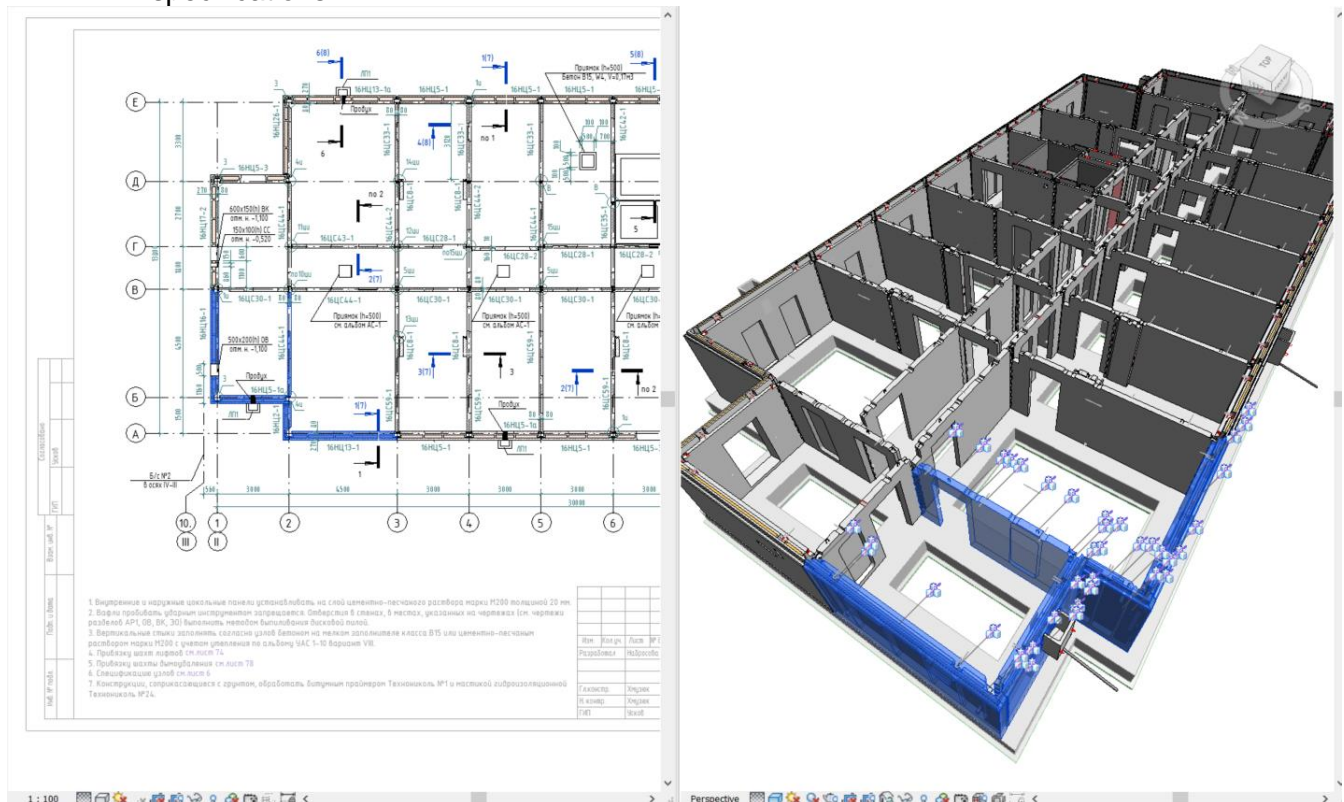
Assembling of 3D models and installation drawing

1. To build a 3D model, you must first create a family of concrete unit

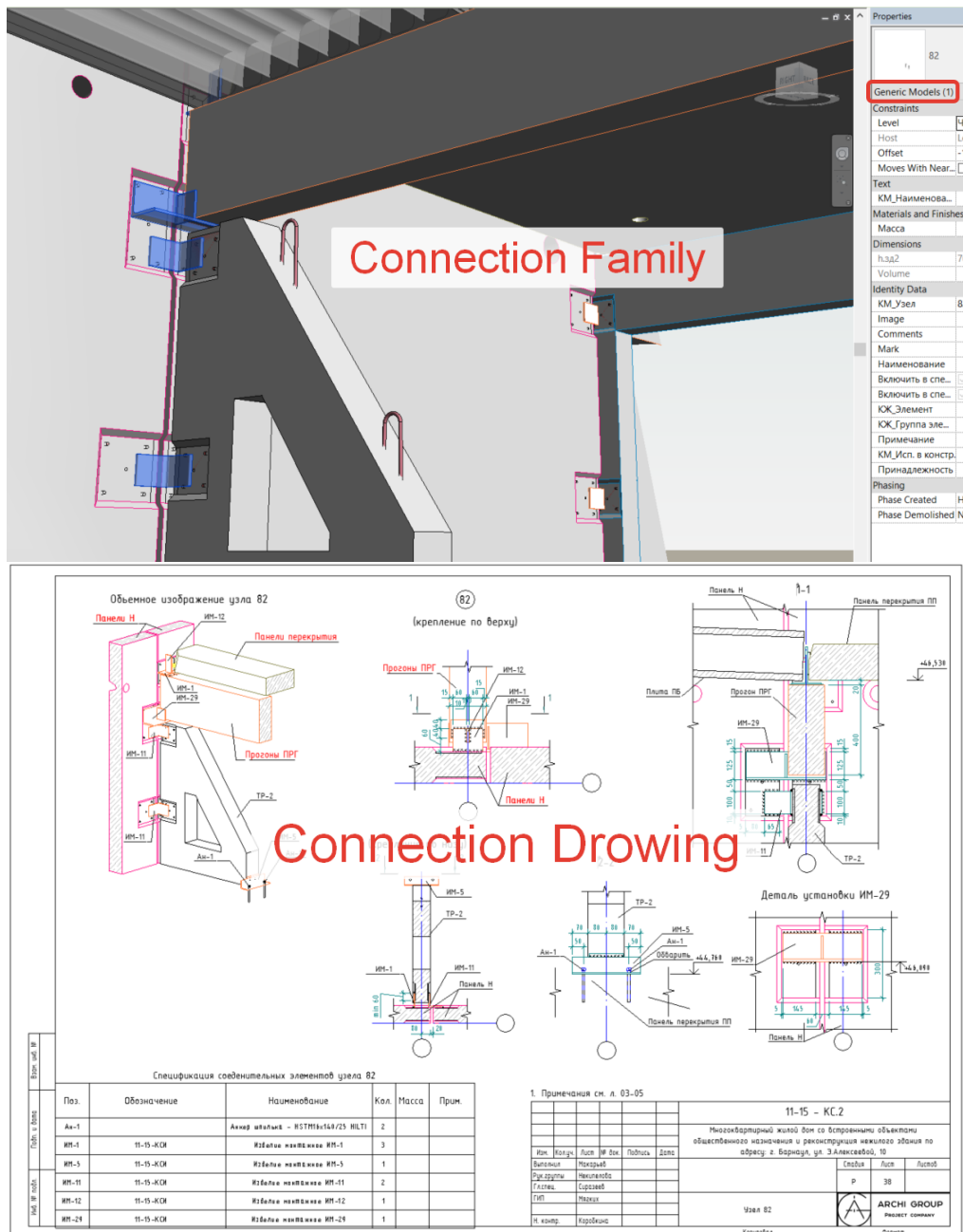
An important feature is that at this stage we do not add 3D reinforcement to the family, otherwise this will make the 3D model heavier to the extent when it is impossible to work even on a high-performance computer.



2. Next, we prepare the installation drawings, draw them up in Revit and adjust specifications



3. Joints for connecting the cast units are parametric families, which we additionally place on the installation drawing



As a result, we have a developed 3D model of the entire building

- We know for sure that the elements fit together
- We have a clear idea of what certain design decisions will look like.
- We know exactly how many and what products to put on the construction site
- We can accurately calculate the number of materials needed to make the connections between the panels

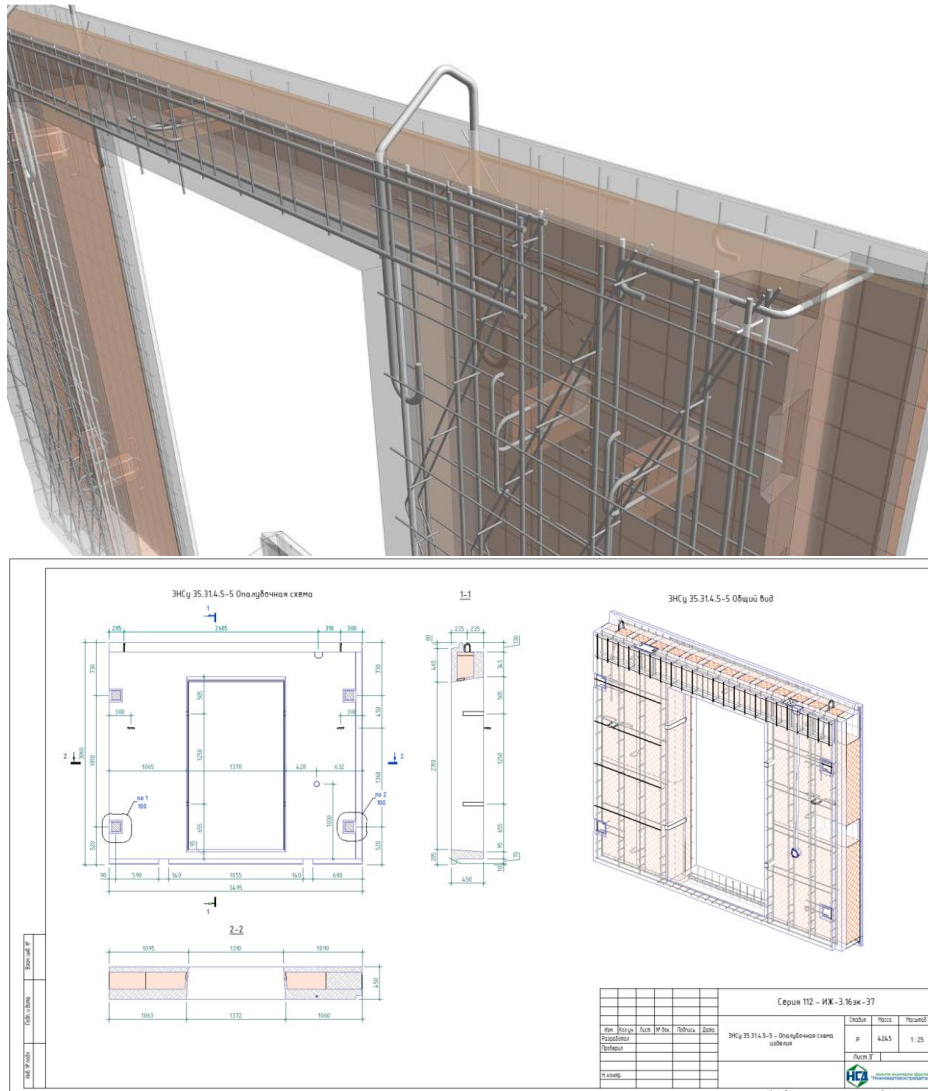
Development of a set of shop drawings

The development of a set of shop drawings is different from the preparation of installation drawing. A lot depends on the factory of the manufacturer on the volume of output, on whether it is equipped with robotic machines or not, and of course on whether the plant personnel is ready to accept files made in Revit.

Two ways to design shop drawings can be drawn from this:

1. 3D.

In the event that the customer needs a 3D model, product development is carried out in a separate file in Revit, and drawings for each product are executed in the same file.



2. 2D

In the event that the manufacturer has its own debugged system for creating drawings and files for robotic machines, there is no need to perform 3D reinforcement of products. In this case, we transfer the 3D unit families to the manufacturer, and they, in turn, develop the documentation in 2D.

Cases when we could use 3D rebar more efficiently than 2D

From all of the above, it becomes obvious that the full cycle of 3D design is superior in quality and speed to traditional 2D methods. In this case, why is it not widely used in the industry?

Costs of the 3D Work approach

In order to effectively design reinforced concrete structures in the full BIM cycle, it is necessary to:

1. Have efficient computers and software
2. Implement BIM technology and staff training
3. Have accumulated experience, a library of elements and solutions

This experience is achieved by great effort within 2-3 years. And many organizations and designers give up after the first unsuccessful attempts to implement BIM.

Pros of working in 2D

1. A wide range of software such as AutoCAD and analogues
2. A huge baggage of knowledge, which Burt began in the 90s
3. Relative simplicity of work in 2D software (for basic AutoCAD training 3-5 days are enough, while 3-5 weeks for Revit)
4. The vast majority of modern engineers know how to use AutoCAD

As a result, there is a situation in which it is much easier not to change anything and work the old way rather than to spend energy and money on the study of new technologies.

Is it worth the time to switch from 2D to 3D?

In my opinion, it's definitely worth it, since with sufficient experience designing in 3D is always faster and more efficient, specialists are highly valued in the market, and organizations have a competitive advantage. The key factor is to gain sufficient experience...

If you never try you will never know